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The amphibolites are "massive or schistose rocks composed chiefly of hornblende, usually with smaller quantities of quartz, feldspar, epidote, and chlorite." They are in most cases dynamically metamorphosed diabases or porphyrites.

The sedimentary rocks of the district are siliceous argillites, clay-slates, quartzites, and micaceous schists. These are altered by both dynamic and contact metamorphism.

The metamorphic processes, excluding weathering, are divided into: (1) dynamic metamorphism, including dynamo-chemical metamorphism, as in the case of the formation of amphibolites from diabases; (2) common hydro-metamorphism produced at low temperatures; (3) hydro-thermal metamorphism, including solfataric metamorphism, and (4) contact metamorphism. The most important characteristic of dynamo-chemically metamorphosed rocks is the production of mosaics. Feldspars are among the most important of the new minerals formed by this process. In hydro-metamorphism the original constituents of rocks are broken down into aggregates with the production mainly of hydrated minerals.

In his discussion of the gold-quartz veins the author calls attention to the fact that the wall rocks of the veins have been much altered by metasomatic processes. The changes effected in them consist mainly in the introduction of carbon dioxide, sulphur, and potassium and the abstraction of silica and sodium. The changes produced in a granodiorite by these processes have resulted in a new rock composed of: sericite = 61.11%, quartz = 25.00%, sphene = .60%, apatite = .46%, pyrite = 2.87%, $FeCO_3$ = .58%, $MgCO_3$ = 2.70%, and $CaCO_3$ = 7.23%. A siliceous argillite, originally consisting of a fine-grained aggregate of quartz, feldspar, brown mica, pyrrhotite, and organic matter, has been changed to an aggregate of sericite, calcite, and residuary quartz. The principal results of the interaction of the wall rock of the veins and the liquids emanating from the vein fissures are thus seen to be carbonates and sericite.

**The Rocks of Castle Mountain, Mont.** — The Castle Mountain mass in Central Montana is an eroded volcano, which presents "all the different types of crystallization and structure possible for an igneous magma to assume under the most varied conditions of cooling and pressure." In general, the rocks have been derived from a siliceous magma rich in alumina and the alkalies. This has given rise to the various members of the granite-rhyolite family in the district. Associated with these, but in much smaller amounts, are found augite-diorite, porphyrites, lamprophyres, and basalts. These are arranged as follows: plutonic rocks in the central core, porphyritic rocks in intruded sheets and dikes, extrusive rocks in lava flows, and tuffs and breccias underlying the lavas. All these different rocks are described in detail by Weed and Pirsson.[1] The plutonic rocks are granite and augite-diorite. They have altered the shales through which they intrude into tough hornstones, and the limestones into coarsely crystalline marbles containing in places garnet, phlogopite, vesuvianite and pyroxene.

The naming of the rock types discussed by the authors is based on their macroscopic texture. In the acid series, for instance, those rocks are called granite which appear holo-crystalline to the naked eye. Those are named quartz-porphyry which possess a groundmass so finely granular that its components cannot be distinguished without the aid of a microscope, and those that contain glass or a very dense groundmass are called rhyolite. In their description of the granite-porphyry the authors describe the micro-pegmatitic structure as an original one and express doubts as to its ever being secondary. Dark basic concretions in the granite are regarded as the result of the liquation of the liquid magma from which the rock solidified. One of the most interesting of the quartz-porphyries described is a rock containing sufficient tourmaline to rank as an accessory component. This mineral occurs in stellate groups replacing feldspar. Very frequently fluorite is associated with it. An analysis of this rock gave:

| $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $K_2O$ | $Na_2O$ | $Li_2O$ | $KH_2O$ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 74.82 | .25 | 13.80 | .37 | .30 | tr. | 10. | .17 | 4.81 | 4.33 | tr. | .83 | = 99.78 |

The lamprophyres cutting the "belt series" of shales, etc., are augite, — vogesites, minettes, monchiquites, and diabases. Many of the rhyolites are devitrified and many of them contain spherulites. These are thought in all cases to be original.

A comparison of the analyses of the different rock types of this district shows that no absolute relation exists between the silica and the different bases; but it seems to indicate that there is a definite relation between the quantities of soda and potash present. The differentiation of the Castle Mountain series appears to have been deep-seated.

The igneous rocks of the Denver Basin, Colorado, are principally basalts, which appear on the plains at the foot of the mountains as dykes and surface flows or sheets. Augite-syenite and quartz-porphyry also occur in the district, but in small quantity only. All the basalts contain orthoclase in fairly large quantity. An analysis of the rock from a dyke at Valmont gives :

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[1] *Bulletin 139 of the U. S. Geol. Survey.* Washington, 1896.

| $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | BaO | MgO | $K_2O$ | $Na_2O$ | $P_2O_5$ | Cl | $SO_3$ | $H_2O$ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48.25 | .89 | 16.73 | 3.99 | 6.28 | 8.32 | .013 | 5.77 | 4.08 | 3.24 | .68 | .08 | .12 | 1.72 | =100.163 |

The augite-syenite is a biotitic variety containing some bronzite.

The tuffs occurring in the district are andesitic. These and certain andesitic pebbles found in conglomerates are the only evidences met with in the study of the district that point to the former presence of andesite lavas in the vicinity.[1]

W. S. B.

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[1] W. Cross, Ch. V. Geology of the Denver Basin in Colorado. Monograph XXVII. *U. S. Geol. Survey*, p. 315.